

CLAIMS

What is claimed is:

1 1. A process system comprising:

2 an impurity separation subsystem to remove a selected
3 impurity from a feed water and to produce a reject solution
4 with an elevated level of the selected impurity and an output
5 solution having a substantially reduced level of the impurity;
6 and

7 an electrolytic membrane separation (EMS) subsystem in
8 fluid communications with the impurity separation subsystem,
9 the EMS subsystem to receive the reject solution from the
10 impurity separation subsystem and an electrically conductive
11 solution, to transfer the selected impurity to the conductive
12 solution.

1 2. The process system of claim 1, wherein the EMS
2 subsystem further increases concentration of the reject
3 solution for reuse.

1 3. The process system of claim 2, wherein the impurity
2 separation system is an ion exchange unit that comprises ion
3 exchange resin that filter the selected impurity from the feed
4 water.

1 4. The process system of claim 3, wherein the reject
2 solution is a brine solution used to regenerate the ion
3 exchange resin.

1 5. The process system of claim 2, wherein the reject
2 solution is a diluted brine regenerate solution that achieves
3 an increased concentration through off-gasing.

1 6. The process system of claim 1, wherein the EMS
2 subsystem further produces a diluate after removal of the
3 selected impurity from the reject solution and outputs the
4 diluate to a flow including the output solution.

1 7. The process system of claim 1, wherein the EMS
2 subsystem comprises
3 a first cell frame comprises an anolyte compartment to
4 house an anode, the anolyte compartment comprises a first in-
5 flow port and a first out-flow port;
6 a second cell frame having a catholyte compartment to
7 house a cathode, the catholyte compartment comprises a second
8 in-flow port and a second out-flow port; and
9 a membrane positioned between the anolyte compartment and
10 the catholyte compartment.

1 8. The process system of claim 7, wherein the
2 conductive solution is supplied to the anolyte compartment of
3 the EMS subsystem through the first in-flow port and the
4 reject solution is supplied to the catholyte compartment of
5 the EMS subsystem through the second in-flow port.

1 9. The process system of claim 8, wherein the reject
2 solution is a brine solution used to regenerate an ion
3 exchange resin.

1 10. The process system of claim 9, wherein the EMS
2 subsystem produces a reusable brine solution after transfer of
3 the selected impurity to the conductive solution for output
4 from the second out-flow port and outputs the conductive

5 solution with the selected impurities via the first out-flow
6 port as waste.

1 11. The process system of claim 7, wherein the
2 conductive solution, being negatively conductive, is supplied
3 to the catholyte compartment of the EMS subsystem through the
4 second in-flow port and the reject solution is supplied to the
5 anolyte compartment of the EMS subsystem through the first in-
6 flow port.

1 12. The process system of claim 1 further comprising:

2 a pre-filtration system in fluid communications with the
3 impurity separation system where the feed water is a filtrate
4 being a filtered feed water.

1 13. An electrolytic membrane separation (EMS) subsystem
2 comprising:

3 a first cell frame comprises an anolyte compartment to
4 house an anode, the anolyte compartment comprises a first in-
5 flow port and a first out-flow port positioned above said
6 first in-flow port;

7 a second cell frame having a catholyte compartment to
8 house a cathode, the catholyte compartment comprises a second
9 in-flow port and a second out-flow port positioned above said
10 second in-flow port; and

11 at least one membrane positioned between the anolyte
12 compartment and the catholyte compartment,

13 wherein the EMS subsystem is adapted to (i) receive a
14 brine solution, used to regenerate an ion exchange resin and
15 having an elevated level of at least one type of impurity,
16 into one compartment of the anolyte and catholyte

17 compartments, (ii) receive a conductive solution having a
18 volume substantially less than a volume of the brine solution
19 into a different compartment than the compartment supplied
20 with the brine solution, (iii) remove the at least one type of
21 impurity from the brine solution, and (iii) produce a resultant
22 brine solution that may be reused for regeneration of an ion
23 exchange resin.

1 14. The EMS subsystem of claim 13 further producing a
2 waste solution including the conductive solution having at
3 least one type of impurity.

1 15. The EMS subsystem of claim 13, wherein the catholyte
2 compartment to receive the brine solution and the anolyte
3 compartment to receive the conductive solution.

1 16. The method of claim 13, wherein the anolyte
2 compartment to receive the brine solution and the catholyte
3 compartment to receive the conductive solution being
4 negatively charged.

1 17. A method comprising:
2 providing an electrolytic membrane separation (EMS)
3 subsystem that comprises a plurality of compartments each
4 including an electrode being one or an anode and a cathode;
5 supplying a brine solution having a first volume and an
6 increased level of an impurity to a first compartment of the
7 plurality of compartments;
8 supplying a conductive solution to a second compartment
9 of the plurality of compartments, the conductive solution
10 having a second volume substantially less than the first
11 volume; and

12 energizing the electrodes to cause ions associated with
13 the impurity to migrate from the reject solution to the second
14 compartment; and
15 outputting the conductive solution having the impurity as
16 waste.

1 18. The method of claim 17 further comprising:
2 outputting a resultant brine solution for reuse in
3 regenerating ion exchange resins.

1 19. The method of claim 18 further comprising:
2 off-gasing the brine solution as the impurity has been
3 removed to produce the resultant brine solution.

1 20. The method of claim 17, wherein the impurity
2 comprises one of a monovalent ion and a heavy metal.

1 21. The method of claim 17, wherein the impurity
2 comprises one of a monovalent ion and a heavy metal.